Società Generale Immobiliare (SGI) Prefabrication Methods for Italian School Buildings in 1960s

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Introduction: Notes on Italian School Buildings in the 1960s

In Italy, at the end of the 1950s, a new approach to construction was needed, in line with other European countries. The Italian post-war reconstruction had pursued a traditional approach, favoring unskilled worker employment. Except for some iconic buildings, construction methods had undergone little evolution compared to the 1930s; the introduction of machines able to speed up traditional techniques had been the most important innovation in on site construction.

In the early 1960s, the strong demographic growth due to improved economic conditions and the increase of national industrialization ignited the debate on prefabrication.

In 1958 the AIP (Associazione italiana per lo studio e lo sviluppo di materiali e sistemi di prefabbricazione) called the first Congress on prefabrication in Naples, in conjunction with Fiera della Casa at the Mostra d'Oltremare. This event highlighted the potential of prefabrication also for school buildings, therefore it confirmed dealings between the AIP and the Ministero della Pubblica Istruzione. This resulted, in 1959, in a ten-year school program enacted by the national government and the first competition for prefabricated buildings was announced.

The renovation of school buildings was an important issue: in 1960 the XII Milan Triennale focused on house and school which were the main sectors affected by population growth. Therefore, they were good occasions for experimentation in prefabrication. The renewal of school buildings was necessary not only for construction aspects but also for pedagogical issues: prefabrication was also interpreted as a tool to pursue innovative teaching models for which traditional buildings were no longer considered suitable. In fact, interdisciplinary collaboration in design was one of the themes of the International Congress of School Building during the XII Triennale.

Regarding the regulatory framework, the state budget for prefabricated school buildings was strengthened by law n. 17 of 01/26/1962: the budget increased from 1.4 billion lire allocated with law n. 53 of 02/15/1961 to 20 billion lire in order to "provide for the deficiency of school classrooms". In 1962 a two-stage national competition was announced, aimed at the construction of 339 school buildings in 35 Italian provinces. 108 companies were invited; 24 passed the first phase and 21 of these were entrusted for the execution, under the Istituto di Sviluppo dell'Edilizia Sociale (ISES) construction management [1].

The first phase of the competition was useful to qualify the construction systems with modular elements proposed by the companies, as well as to express an opinion on their technical and economic capacity to execute the works [2]. It was clear that this was an experimental competition, just as the buildings to be built were experimental, so a preliminary assessment was needed to highlight any design deficiencies. Despite the strong promotion of prefabrication in school buildings, it should be noted that the exhibition of prefabricated schools organized in Rome by the Ministero della Pubblica Istruzione in 1962 showed poor results and was mainly of normal prefabricated houses adapted for schools [3]. Therefore, the national competition included a phase of comparison with the companies, as well as supporting them

regarding construction choices as to the best way to pursue the construction of innovative buildings technologically suited to new pedagogical needs. The first round in the national competition for school buildings ended in the autumn of 1965 (18 months after construction began in the spring of 1963): 339 buildings (2767 classrooms total) were completed at a cost of approximately 18.6 billion lire [4].

There were other initiatives, which more generally highlight how fundamental the role of the Public Client is for the development of industrialization processes; school buildings were probably the main test bed for prefabrication in Italy. In 1965 a new law was enacted (Regulation n. 5112 of 05/06/1965) that dictated provisions for the construction of school buildings with prefabricated modular elements (comparing them to traditional ones). It increased government funding for experimental school building programs (already allocated by laws n. 47/1963 and 1358/1964), increasing it up to 4.6 billion lire. This was another sign of the stimuli given by the public administration to the construction industry [5].

In1965 the Ministero dei Lavori Pubblici announced a new competition for the construction of 26 buildings in 11 Italian regions: 14 primary and 12 middle schools. 100 Italian construction companies were invited: 19 of these were chosen for their construction systems, including Sogene, the subsidiary construction company of the Società Generale Immobiliare (SGI)[6].

It also operated in prefabrication fields and in the 1950s it built some iconic towers in Milan, referred to as the so-called traditional evolved construction methods [7]. In 1963 it became the exclusive licensee of the French Acier-béton Estiot patent, [8] through which it responded to the market requests for the large volumes of economic housing commissioned by the Istituti Autonomi Case Popolari (IACP) in the early 1960s [9]. Construction companies that had already started experimenting with prefabrication systems in public housing, had (even if minimal) experience which allowed them to respond to calls for school buildings.

Sogene was one of these: after the construction of the towers in Milan and experimenting with heavy prefabrication techniques for low-cost housing, the company expanded the application of industrialized techniques also for school buildings. Interest in schools followed the national trend, so that many Italian companies experimented with prefabrication for this type of construction, encouraged by the Ministero della Pubblica Istruzione calls.

This paper refers to some of SGI's enterprises in school buildings. In particular, it deals with the "S3M" prefabrication system developed by Sogene for the construction of an elementary school in the province of Padua in 1965; Sogene re-proposed this system for participation in other ministerial tenders (also in its "S4" variant) up to the late 1960s. The development of other projects documents Sogene's interest in the topic; some experiences are analyzed below, relating them to the Italian constructive framework of the time.

SOGENE's Construction System for School Buildings

In the 1960s, SGI followed national trends: for the construction of cheap housing it obtained a French patent for a heavy prefabrication system and two years later (1965) developed its own prefabrication method with modular elements to participate in the competitions announced by the Ministero della Pubblica Istruzione.

The "S3M" construction system which gained Sogene the contracts, is described below. Under the Istituto di Sviluppo dell'Edilizia Sociale (ISES) construction management it built the elementary school in Casale di Scodosia in the province of Padua, one of the 26 sites identified by the tender launched by Ministero della Pubblica Istruzione in 1965. The description is taken from an official SGI document dated around 1970 [10]. It is a sort of catalogue, developed after the construction of the school in Casale di Scodosia; it illustrates the "S3M" system and its "S4" variant.

In the 1960s, the Italian government was not particularly "demanding" for economic social housing, accepting mere re-proposals of foreign heavy prefabrication systems with no remarkable results. However, it was more demanding for school constructions, at least for those referred to experimental models: it essentially indicated an idea to complete them with the construction companies' proposals. The competition included a first phase in which construction companies had to present and qualify their construction system; it could be accepted, modified or rejected. After approval it was possible to proceed to the second construction phase.

The Sogene "S3M" system was presented as a tool that allowed the construction of buildings "with any planimetric and altimetric layout[11]". It contemplated the use of U-inverted precast reinforced concrete beams that were packaged in multiple module sizes of 2.10 metres: 4.20 metres long, 6.30 metres long, or 8.40 metres long. They allowed the creation of grids of beams with a distance between centres of 2.10 metres and slabs of 6.30x6.30 metres or 8.40x4.20. Beam cores were prepared for the plant passages; therefore, they were packaged with transversal holes with a diameter of 25 centimetres. The reinforcements were made of electro-welded mesh and ribbed steel with a high elastic limit.

For the "S4" variant, beams were packaged in multiple module sizes of 4.20 metres that allowed the realization of modular slabs with supports 12.60 or 16.80 metres apart (useful for gyms and meeting rooms) or grids of 16.80x16.80 metres. This type of grid was realized by 8 pillars along the perimeter and a 2.10 metres' cantilever along it. In the rectangular section of the beams there were holes with a diameter of 45 centimetres. Floors arranged between the beams of the "S3M" system were made up of prefabricated lightweight concrete slabs with dimensions of 2.10x2.10 metres or 2.10x4.20 metres. Lightening was obtained by sheets of material called "Leca 600" interposed between the upper and lower thin insoles, connected by ribs. The slabs thickness (8 centimetres) was given by two sheets (1.5 centimetres thick) reinforced by high elastic limit electro-welded steel mesh and by "Leca 600" sheet (5 centimetres thick). For the "S4M" system, the slabs were 12 centimetres thick, owing to two concrete slabs (upper and lower) of 2 centimetres (reinforced by electro-welded meshes) and one slab in "Leca 600" (8 centimetres thick).

The pillars were also prefabricated with concrete reinforced by high elastic limit steel (ALE). At the bottom they are prepared with a slub for interlocking in the plinth; at the top with a hole for inserting the armor connection to the horizontal structures and for anchoring the pillar of the upper floor.

The building shell was made up of sandwich panels with a total thickness of 17.5 centimetres: external concrete slab of 5 centimetres (which remains exposed), insulation consisting of 3 centimetres of expanded polystyrene and 8 centimetres of "Leca 600", 1.5 cm internal concrete slab. The joints between the façade panels were sealed with high elasticity mastic. The sandwich was useful for obtaining good levels of performance for thermal insulation: the panels were characterized by a transmittance of 0.53 W/m2K, or 0.68 W/m2K taking into account heat bridges [12]. Prefabricated concrete panels were exposed and could be externally characterized by textures prepared in the formworks; they could be different depending on the building. This reflected a typically Italian approach to prefabrication methods: Italian designers were often worried about not being able to customize the building shell [13]. The Sogene catalogue for prefabricated schools contemplated this possibility, so as to have a wider offer.

Windows had frames in natural anodized aluminium with simple, double, printed or wired glasses, equipped with wooden or PVC roll-up shutters.

Internal walls were also made by 10 cms thick sandwich panels; they were formed from two 2.4 cms thick concrete slabs in the middle of which it was placed a soundproofing panel made by Eraclit [14] and tar paper (5 cms thick). The joints between the panels were closed with Eraclit and smoothing on site based on high resistance sealants. In the Sogene catalogue, this stratigraphy is reported as a "update" of the one used for internal walls of the Casale di Scodosia school as it had better performance from the soundproofing point of view, being characterized by a curve always higher than the limit imposed by the ISES; it corresponds to an evaluation index of 43 at a frequency of 500 Hz. The attention to the

performance of technical elements pursued by Sogene was clear; as a result of the construction of Casale di Scodosia school, the company included its system "in the catalogue", with some improvements.

The use of special formwork for the packaging of the panels (both for internal walls and shell) provided perfectly smooth visible surfaces, to the advantage of finishing operations. Then the paint was applied directly, after localized smoothing on small imperfections. The walls, depending on the environments, could alternatively be finished with the application of plastic sheets or coatings, improving hygiene requirements.

Acoustic insulation was also required for the floors, so false ceilings were implemented in the rooms and in the gyms: they were made by sandwich panels consisting of a 2 cm thick Eracoustic [15] panel and a 1 cm thick Eraclit panel, with tar paper interposed. The roof is of the flat type: above the structural slab a cellular concrete screed was made with overlying layers of crossed asphalt for waterproofing and a tile floor. The thermal insulation requirement was satisfied by "Leca 600" layer arranged in the slab [16] and by the false ceiling and its air chamber; ultimately, the roof was characterized by a thermal transmittance of 0.60 W/m2K.

The ground floor slab was prefabricated, resting on concrete walls that were pierced for systems passage and designed to form a 120-cm-high ventilated cavity.

The stairs were cast in place, with walls of the cage that had a bracing function.

The ground floor covering was in vinyl resins. On the upper floor, classrooms and corridors had fine or medium marble floor-tile glued onto cement screed. The gym had an industrial rubber floor. Staircase (tread and rise) and meeting room floor were coated with marble. Grès tiles used for services: WCs, showers, changing rooms, kitchen and dining room. Depending on the flooring material, plastic or marble skirting boards were available.

The water system was made with galvanized iron pipes for supply and lead for the drainage, equipped with a water reserve to ensure the daily supply provided for by the ministerial regulations. The fire-extinguishing system (independent from the potable water one) was made with black steel pipes, fed by the city water network and equipped with storage tanks. The heating system was designed to guarantee a perceived temperature equal to 19 °C (18 °C real) by means of steel radiators in the classrooms and others rooms, exception for the gym where unit heaters were only used when necessary, resulting in energy savings. All thermal units were powered by a diesel central heating plant supplied by underground metal tanks. The lighting system was designed to ensure a good lux degree depending on the environments: in study rooms, classrooms and corridors there was semi-direct lighting using fluorescent lamps (resulting in energy savings) and incandescent lamps in service rooms and outdoor spaces.

The Sogene catalogue also reports a cost parameter per square metre (referred to January 1970) for the construction of school buildings using “S3M” and/or “S4” system: 80,000 lire/sqm. This parameter was obtained was obtained by dividing the construction’s parts. The structure cost about 40,000 lire/m2 (50% of the total): 33,000 lire/m2 (41% of the total) it refers to the prefabricated ones and consequent labour for mounting, the remaining part (41% of the total) for traditional reinforced concrete works. Systems cost about 16,500 lire/m2 (20% of the total), the last part (30% of the total) refers to finishes (floors, paintings, coverings, false ceilings), fixtures and waterproofing.

Casale di Scodosia Elementary School

Casale di Scodosia (province of Padua) elementary school was built by Sogene with “S3M” construction system in 1966; it has 5 classrooms. The plan layout is very regular, arranged around an outdoor half-courtyard. It is a single-storey building with large full-height windows that define wide lighting surfaces. Roof beams are very distinctive: they have considerable height, defining an overhang over the entire perimeter of the building.

The building layout is set on a grid with a module equal to 70 cms (sub-module of 2.10 metres featuring the beams), clearly evident studying the plan. According to the system description or possible dimensional configurations, each classroom expands within a structural bay with dimensions of 6.30x6.30 metres or 9x9 modules. Close to classrooms, corridors expand within a structural bay with dimensions of 6.30x4.20 metres or 9x6 modules. There is also a wide meeting room of size equal to 8.40x12.60 metres or 12x18 modules without columns in the central part, supported by 10 perimetric pillars. Also spaces for services, infirmary, hall and central heating plant observe the layout grid. The roof and its overhang (that has size of 2.10 metres or 3 modules) relate all rooms and spaces, including the outer one (covered patio and half-courtyard) (Figs. 1-2).

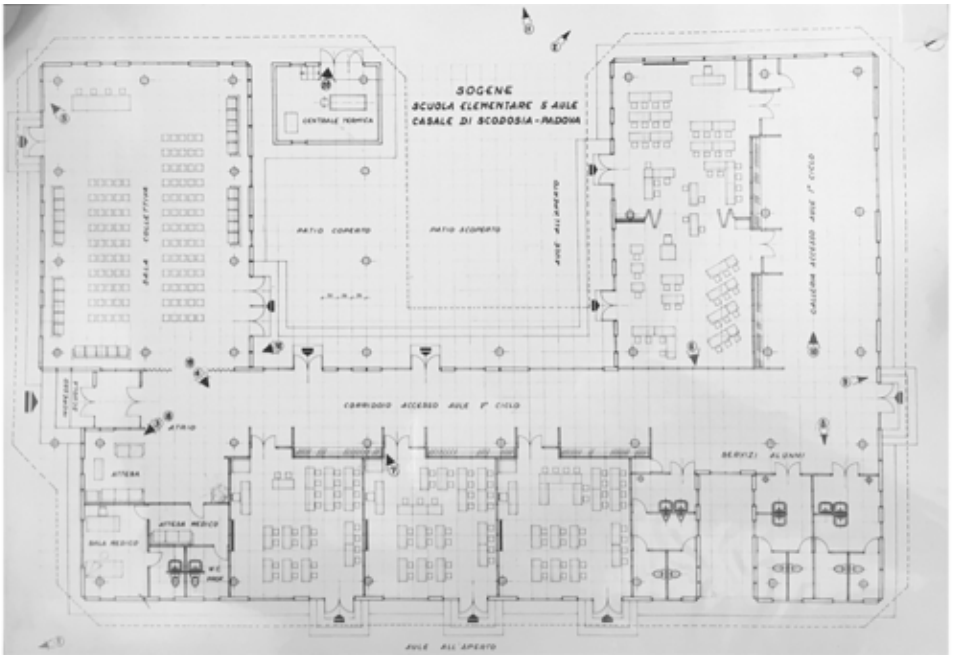

Figure 1: Casale di Scodosia school layout. Courtesy of "Ministero per i Beni e le Attività Culturali", Archivio Centrale dello Stato (Rome), SGI collection (subsequent citations ACS-SGI), folder 4091-261, Scuole prefabricate

Figure 2: Casale di Scodosia school: photos of the building. Source: ACS-SGI, folder 4091-261, Scuole prefabbricate

Even panels of the shell follow the modular logic, having dimensions equal to 70 or 140 cms (width) and full height; fixtures are inserted alternately with the matt panels (possibly including opaque parts) avoiding interference between the two types of closure.

Vertical partition panels between first and second grade classrooms are movable, allowing to shape a single wide space mixing the two classrooms. This ploy took into account innovative pedagogical guidelines that the Ministero della Pubblica Istruzione had released in the 1960s, as mentioned in the introduction.

Other Sogene projects for school buildings

Sogene implemented projects for other school buildings, although not realized: a high school in Frascati (province of Rome), a secondary school in Montale (Tuscany), a school complex in Rome and two prefabricated schools in Milan.

The Frascati school was designed for 25 classrooms, as a result of a competition announced in 1968; it was a project for an industrial technical institute. Also in this case, building layout was characterized by a modular grid within which classrooms, workshops, laboratories, gymnasium, offices, meeting room, and caretaker's accommodation were organized. In addition, the outdoor area was equipped with basketball and volleyball courts, an auditorium and a parking area. Design perspectives were very suggestive: they gave an idea of the construction technology and at the same time highlighted the space, clearly designed to encourage gathering of the students (Fig. 3).

Figure 3: High School in Frascati: project perspective. Source: ACS-SGI, folder 4091-261, Scuole prefabbricate

The project of the elementary school in Segrate (province of Milan) contemplated 15 classrooms; it should have consisted of two buildings (the school and the gym). The elevations were marked by modular façade panels and the high roof beam, overhanging the entire perimeter (Fig. 4). Still with “S3M” and “S4” systems, Sogene designed another secondary school of 12 classrooms in Montale (province of Pistoia) (Fig. 5) and a school complex titled Sampierdarena II in Rome which

consisted of nursery school with 3 classrooms, elementary school with 24 classrooms and a secondary school with 18 classrooms (Fig. 6).

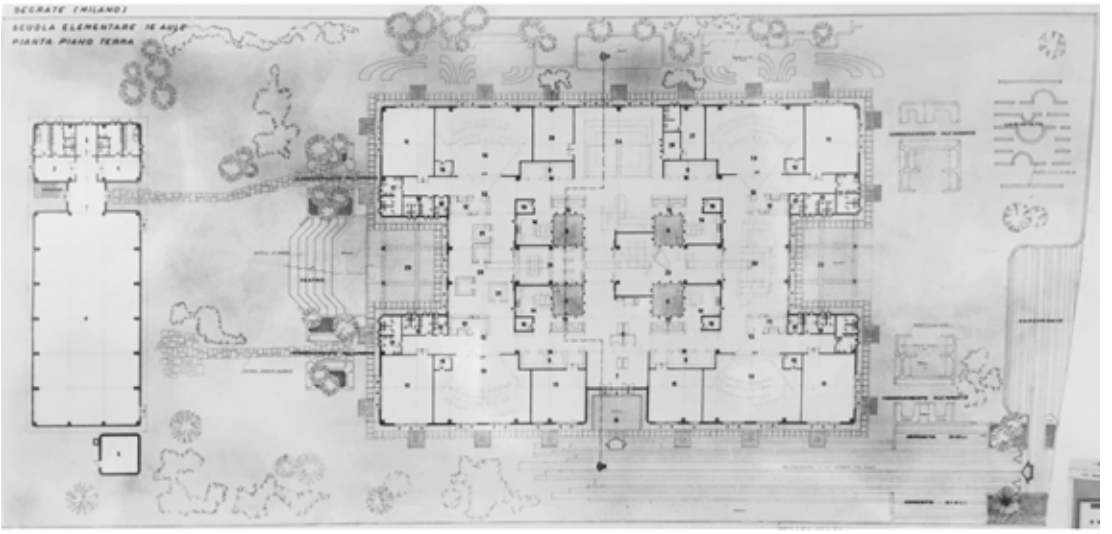

Figure 4: Elementary school in Segrate: layout. Source: ACS-SGI, folder 4091-261, Scuole prefabbricate

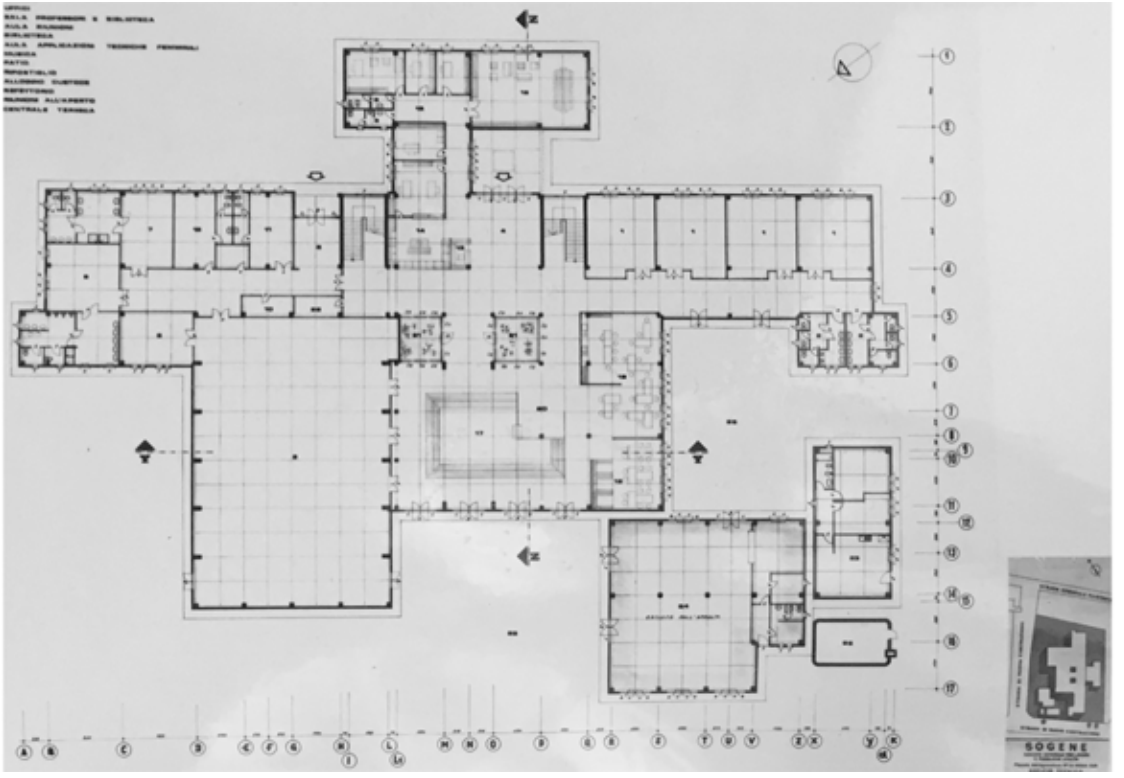

Figure 5: Secondary school in Montale: layout. Source: ACS-SGI, folder 4091-261, Scuole prefabbricate

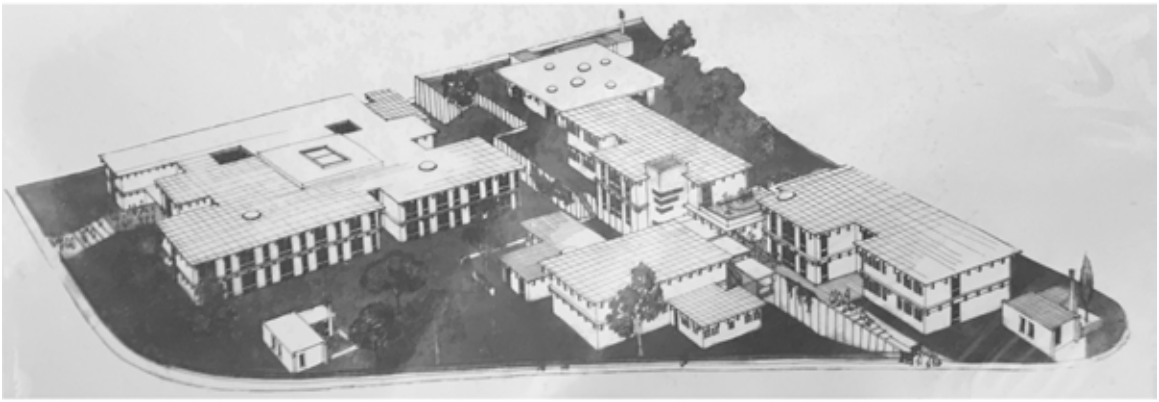

Figure 6: "Serpentera II" school in Rome: axonometric drawing of the complex. Source: ACS-SGI, folder 4091-261, Scuole prefabricate

Although Sogene used its construction system only for Casale di Scodosia school, the projects listed highlight company's commitment to contributing to the experiments on the subject, which occurred in Italy in the second half of the 1960s through tender-competition.

Studying SGI's archive, there are documents about the construction of two identical prefabricated schools in Milan, dated between 1964 and 1965: the high school in Uruguay street and the primary and secondary schools in Faenza street [17]. They were built using heavy prefabrication systems, which were widespread in northern Italy in the mid-1960s. Photographs of the construction sites highlight the buildings' assembly: it was made up by large two-dimensional elements, like reinforced concrete panels for facades and floors (Fig. 7). It was a less advanced system than the one that would be developed two years later for the competition for Casale di Scodosia school in 1965: these two Milanese schools were made up by panels as large as one structural bay (or more), mounted by crane or mobile crane, instead of with 70-cm modular elements. Slabs were armed plates, reinforced in longitudinal and transverse directions to allow correct stability and resistance during handling. The façade panels had a cladding in small elements prepared in the formwork and holes suitable for traditional window assembly, instead of transparent panels to replace the matt ones as in Casale di Scodosia school.

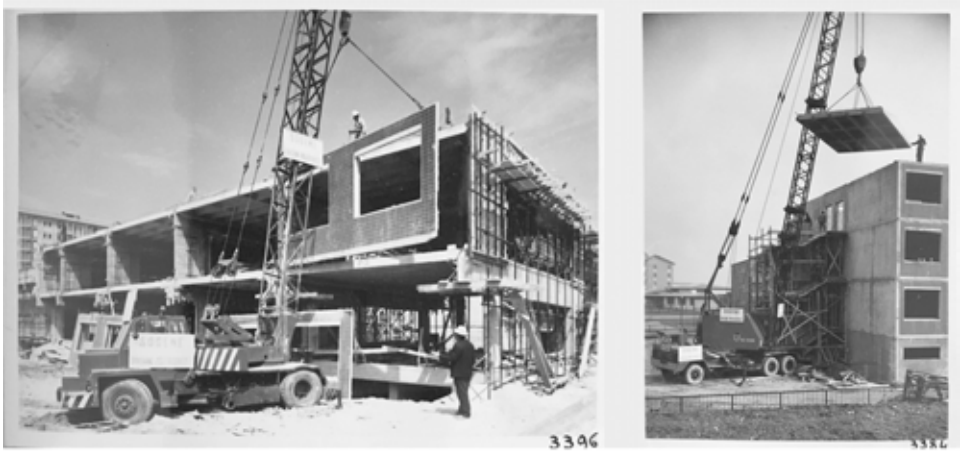

Figure 7: Schools built using heavy prefabrication systems in Milan. Source: ACS-SGI, folder 4091-265, Edilizia civile 2

Compared to this, the two Milanese schools were very different technologically, certainly dependent to dissimilar recommendations from the public client. Probably the two Milanese buildings were the result of the great general demand for school buildings that occurred in the early 1960s, due to the significant population increase and the extension of compulsory schooling up to 14 years. They were not experimental constructions, but were ordinary production systems, subject to execution speed constraints to which SGI responded by means of a heavy prefabrication construction system [18]. In fact, Sogene had been the Italian dealership of the French *Acier-béton Estiot* patent since 1963, when the company had participated in the construction of cheap housing for workers following the great requests made by IACP of northern Italy, in the early 1960s.

Conclusions

This study contributes to the reconstruction of part of the SGI's work, a construction company engaged in all fields of construction and civil engineering, which in its third and most prosperous period (from the post World War II period to the early 1970s) provided a contribution to various national trends [19]. Although the company was mainly involved in the construction of large residential complexes, office, executive buildings and some industrial constructions, its strong business organization allowed the company to take part in experimentations promoted by the Ministero della Pubblica Istruzione in the 1960s. Although SGI did not have a portfolio of school buildings comparable to its residential one, the technological effort made by the Company to respond to the 1965 national competition was certainly valuable. So much so that it developed a dedicated system that was subsequently reused to participate in other state competitions, even though the SGI buildings were not built.

In general, Public Client was the main vehicle for the development of industrialization processes and methods in the Italian construction history. This had been known for some time: at the 1965 "*Convegno nazionale sui problemi dell'industrializzazione edilizia*" (National Conference on building industrialization issues) experts agreed that the Government should be the main client for industrialized constructions and also that experiments in school buildings would implement new prefabricated methods. Indeed, in the early 1960s, prefabrication in Italy had developed through the importation of foreign systems, in case the Client's requests changed for the school [20]. It no longer required a quick and large "housing supply" like the IACP in northern Italy, it demanded systems specifically defined "*ex novo*" by companies to respond to the Ministero della Pubblica Istruzione requests, following wider systematic changes linked to new pedagogical models. Therefore, SGI focused on a prefabricated system specifically designed for school buildings, and Sogene used for that of Casale di Scodosia for its participation in various national competitions. Although the SGI was in its period of maximum construction production, especially in the residential field, it also undertook new experiments. This circumstance confirms, also through the specific SGI's experience, that the great "bet" on prefabrication happened in Italy in the early 1960s, initially with economic residential construction, then also with schools. Experiments lasted for the whole decade and continued until the first half of the following one, defining a precise period, not continuing to today.

Therefore, there is a built heritage that is the memory of a national historic construction phase, which is concretely manifested in the presence of technologically unique buildings, often the result of "tailor-made" [21] industrialization experiences, which are worthy of study in order to preserve the building and its technological uniqueness because it represents a built testimony. This is very important because the management of school buildings passed from the State to the Regions starting from the mid-1970s; this interrupted experiments and caused the loss of control over single buildings at a centralized level, especially for maintenance.

The many school prototype buildings present in Italy today, most of which are still in use, correspond to as many construction stories: case studies can help to define guidelines for their maintenance and, more generally, to the strengthening of knowledge concerning the relationships between the construction company system and the evolution of construction techniques.

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[2] Ibidem.
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[10] Archivio Centrale dello Stato (Rome), SGI collection, folder 4091-261, *Scuole prefabbricate*
[11] ibid.
[12] The document refers to tests commissioned by the company to the Galileo Ferraris Institute laboratory in Turin, carried out taking into account the thermal bridges given by the concrete joints.
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[14] Eraclit "consists of vegetable wool (poplar fraying) treated to be incombustible, antiseptic and rot-proof with impregnations (magnesite) and plastered with a special cement mixture". Source: E. A. Griffini, *Dizionario nuovi materiali per edilizia*, Milano: Hoepli, 1935, p. 25.
[15] This material probably was obtained from glued and compressed wood fibres, with sound-absorbing features.
[16] The stratigraphy of the roof slab is the same as that already described for the inter-floor slab: two 1.5 cm concrete panels with a 5 cm thick "Leca 600" panel interposed.
[17] Archivio Centrale dello Stato (Rome), SGI collection, folder 4091-265, *Edilizia civile 2*
[18] From the dates reported on the archival documents, construction sites started in mid-1964 and the buildings were completed before the start of the new school year (September 1965).
[19] Spada, (Note 7).
[20] Poretti, (Note 9).
[21] I. Giannetti, 'Industrializzazione "su misura": le scuole-pilota di Luigi Pellegrin (1967-1975)' in S. M. Cascone, G. Margani, V. Sapienza (Eds.) Nuovi orizzonti per l'architettura sostenibile, Atti Colloqui.AT.e 2020. Monfalcone (Gorizia): EdicomEdizioni, 2020, pp. 35-47.